LOW PROFILE COMPUTER CASE AND COMPUTER

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The invention relates to computer cases and computers and more specifically, the invention relates to a low profile computer case and computer.

2. Description of the Related Art:

As computers become more ubiquitous in society, it becomes more desirable to reduce the size of computer systems. Currently, there is a clear trend toward more powerful and more compact computer systems. Accordingly, the consumed power per unit density, i.e. the power density, of the average computer has increased tremendously over the past several years. However, such an increase in power density runs into a limitation of heat dissipation. More specifically, the higher the power density, the more heat generated and the more difficult it is to dissipate the heat. Of course, heat adversely affects the operation of most microprocessor based components and other computer components. Accordingly, the desire to reduce the size and increase the power of computers is at odds with the need to maintain components at temperatures within desired operating ranges.

Essentially, there are two processes by which heat in a computer case is dissipated. The first process is "air exchange cooling" which consists of replacing heated air in the case with cooler air, e.g. ambient air. The second process is "forced cooling" in which air is moved across the surface of a specific component to raise the convective heat transfer coefficient for the surface of the component thereby cooling the component faster than if the component was in static air. Most computer cases incorporate both heat dissipation processes to some degree. Both processes require the

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movement of air.

It is well known to use fans to move air through computer cases to cool various components therein. Conventionally, such fans are placed in a front panel or a back panel of the computer case. However, the desire to reduce the size of computers requires that front and back panel space be utilized efficiently for accessible components such as communication ports and power connections on the back panel, and removable media and fixed media drives on the front panel. Accordingly, the use of a fan in the front or back panel wastes precious panel space. Fans have been placed in side panels to avoid this problem. However, popular rack mount systems, such as systems complying with Engineering Industries Association Standard 310-C (EIA-310-C), require that the computer case be mountable in a rack having sides that closely oppose side panels of the computer case. Accordingly, side panels of the racks may interfere with operation of fans mounted in side panels of computer cases and thus the practice of mounting fans in side panels of computer cases has limited application. Further, it is often desirable to mount sliding rails on the computer case to permit it to be slid out of the rack for maintenance and the like. Such rails interfere with fans mounted in side panels. The use of shelves to avoid the need for rails restricts vertical room.

It is also known to provide one or more fans in an interior of a computer case. U.S. patent 5,793,610 is exemplary of references disclosing such an arrangement. U.S. patent 5,793, 610 discloses a computer case having a support member in an interior of the case. Plural cooling fans are mounted in the support member. If one of the fans fails, air tends to re-circulate back through the opening in which the failed fan is mounted and thus a complex louver arrangement is provided.

U.S. patent 5,168,424 discloses a data storage unit having a housing and internal plate 105. Two open loop dc centrifugal fans are mounted in plate 105 to draw air from an area housing memory devices to an area housing a power supply. U.S. patent 5,168,424 uses dual entry open loop

centrifugal fans to adjust for a variable impedance to air flow caused by varying numbers of memory devices on the upstream side of the fans. The downstream side of the fans contains only a power supply over which air flows to vents in a front panel and thus does not present significant impedance to the system. The intake ports of the fans are positioned opposite data storage devices. The use of two centrifugal fans having intake ports opposite devices requires a large amount of space in the chassis and thus the arrangement disclosed in U.S. patent 5,168,424 is not suitable for a low profile computer chassis which includes a motherboard and other components that require additional space in the chassis.

EIA-310-C, the disclosure of which is incorporated herein by reference, specifies three different rack sizes and the sizes and tolerances of cases that can be disposed in the racks in an attempt to insure that computers and components from various venders will fit in the same racks. There are three standard panel widths, i.e. rack sizes, 19", 24", and 30", with 19" being the most common. The vertical or height dimension of the racks is divided into a plurality of individual units known as a "U". In particular, one U equals 44.45mm ± 0.4mm. The horizontal or width dimension of a case for a 19" rack is 482.6mm ± 0.4mm. Many computer servers or the like are housed in a 6U case, i.e. a case that fits in the width dimension of the 19" rack noted above and is 265.9mm high (44.45mm x 6= 266.7mm - 0.8mm tolerance to permit sliding the case into and out of the rack as prescribed by EIA-310-C).

In accordance with the recent trend in miniaturization, servers have been reduced to 2U cases, i.e. cases 88.1mm in height. However, conventional 2U servers have at most four media drives in the front panel because of the need for fans and to allow for adequate air flow for forced cooling. While components, such as media drives have gotten smaller, at any given time they are designed to fit into standard form factors, such as "half height" drives (approximately 1 5/8 " in height) and "low profile" drives (approximately 1" in height). Accordingly, case size and cooling

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considerations have limited the number of components, such as various media drives, that can be housed in a 2U case. Accordingly, the functionality and flexibility of conventional computers and computer components in 2U cases is limited.

It is important to utilize the limited width of EIA-320-C to its fullest extent also. Accordingly, conventional cases made to fit into standard EIA-310-C racks have side walls with a lip that extends across the top of the case to a small degree to allow a top panel to be screwed onto the lip from the top of the case thereby maximizing the width of the case. As noted above, many cases designed for rack mounting have slide out rails, i.e. drawer slides with rollers, that permit the case to be easily slid out of the rack and maintained in position for repair, maintenance and troubleshooting. The case including the slide out rails must fit within the standard rack width. Therefore, the use of rails, further limits the effective width of a case. Finally, an increased number of components results in an increased number of communication and power cables. If the cables are too bulky and not managed properly, they further restrict air flow and thus cooling. Cabling is one more consideration that puts increased component density at odds with cooling requirements.

SUMMARY OF THE INVENTION

It is an object of the invention to overcome the density/cooling limits of conventional standard rack mount computer cases.

It is another object of the invention to maximize the component space in a standard sized computer case.

It is another object of the invention to maximize the volume of airflow in a computer case.

It is another object of the invention to minimize the footprint of a cooling device in a computer case.

It is another object of the invention to use standard "off-the-shelf" components in a compact case.

A first aspect of the invention is a computer case of a standard height adapted to be mounted in a rack of a standard width, and configured to house plural computer components. The computer case comprises an enclosure defined by a front panel, a back panel, two side panels, a top panel, and a bottom panel. A partition is disposed in the enclosure and extends substantially from the bottom panel to the top panel to divide the enclosure into at least a first zone adapted to receive a mother board and a second zone adapted to receive at least one storage device. A centrifugal blower is coupled to an aperture in the partition to cause air flow between the first zone and the second zone.

A second aspect of the invention is a computer case of a standard height adapted to be mounted in a rack of a standard width, and configured to house plural computer components. The computer case comprises an enclosure defined by a front panel, a back panel, two side panels, a top panel, and a bottom panel. A partition is disposed in the enclosure and extends substantially from the bottom panel to the top panel to divide the enclosure into at least a first zone and a second zone. A first centrifugal blower is coupled to an aperture formed in the partition to cause air flow between the first zone and the second zone. An Inlet of the first centrifugal blower faces towards the top panel. A second centrifugal blower is also coupled to the aperture to cause air flow between the first zone and the second zone. An inlet of the second centrifugal blower faces towards the bottom panel and a top surface of the second centrifugal blower opposes a bottom surface of the first centrifugal blower.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be described through a preferred embodiment and the attached drawing in which:

Fig. 1 is a top view of a computer in accordance with the preferred embodiment with a top panel of the case removed;

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Fig. 2 is a sectional view taken along line 2-2 of Fig. 1;

Fig. 3 is a sectional view taken along line 3-3 of Fig. 1 with some components removed for clarity;

Fig. 4 is a partial sectional view taken along line 4-4 in Fig. 1;

Fig. 5 is a front view of the front panel of the computer of Fig. 1; and

Fig. 6 illustrates a modified partition in accordance with the preferred embodiments.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figs. 1-5 illustrate a preferred embodiment of the invention. Computer 10 includes case 20 component bays 30, 32, and 34, mother board 36, and power supply 38. Case 20 of the preferred embodiment is a standard 19" rack mount, 24" deep, 2U case. In other words, case 20 defines a rectangular enclosure that is dimensioned to fit into a standard EIA-310-C 2U space in a 19" rack. As illustrated in Figs. 1 and 2, case 20 is constructed of front panel 22, side panels 24, back panel 26 bottom panel 27, and top panel 28. Note that, as illustrated in Figs. 2 and 3, side panels 24 and bottom panel 27 can be formed of a single sheet with side panels 24 defined by right angle bends in the sheet. Partition 40 extends laterally between side panels 24 and vertically from bottom panel 27 to top panel 28 to divide case 20 into two zones. Aperture 42 is formed in partition 40. Blowers 44 and 48 are mounted in case 20 in the manner described below. Blowers 44 and 48 are centrifugal blowers, such as standard 96mm blowers having mounting channels 53 (blower 48) and mounting channels 55 (blower 44) respectively. For example blowers 44 and 48 can each be a GAMMA 30™ blower sold by Nidec under the part number A34124-33. Manufactures of similar blowers having the same form factor include Delta, Adda, and Indec.

As illustrated in Fig. 2, aperture 42 comprises two rectangular portions 42a and 42b that abut one another. Each rectangular portion is sized to snugly receive an outlet port of one of blowers 44 and 48. In particular, outlet

port 45 of blower 44 is disposed in rectangular portion 42a of aperture 42 and outlet port 49 (see Figs. 2 and 3) of blower 48 is received in rectangular portion 42b of aperture 42. Accordingly, operation of blowers 44 and 48 creates a low pressure in a zone in front of partition 40 and a high pressure in a zone behind partition 40. Of course, this pressure differential results in air flow between the two zones through blowers 44 and 48. In particular, air flows in grills formed in front panel 22, and/or front panels of devices, into inlet 43 of blower 44 and inlet 47 (see Fig. 3) of blower 48, out of outlet ports 45 and 49 of blowers 44 and 48 respectively, and out of holes formed in back panel 26.

Fig. 3 illustrates the mounting configuration of blowers 44 and 48 in detail. Standoffs 57, such as PEMs™, are fixed to a surface of bottom panel 27 and blower 48 is disposed over standoffs 57. Specifically, one of mounting channels 53 of blower 48 abuts the top of one of spacers 57 and one of mounting channels 55 of blower 44 is aligned with the other of spacers 57. Bolts 54 are passed through mounting channels 53 and 55 and tubular spacers 59 and threaded into a tapped hole formed in respective standoffs 57. Tightening bolts 54 serves to fix blowers 44 and 48 in place with inlet 43 of blower 44 facing towards top panel 28 and inlet 47 of blower 48 facing towards bottom panel 27. Note that aperture 42 receives outlet ports 45 and 49 snugly to further support blowers 44 and 48.

Standoffs 57 are sized to provide a standoff distance x between bottom panel 27 and blower 48. Distance x defines an intake area that is roughly distance x multiplied by the circumference of inlet 47 of blower 48. The intake area preferably is substantially equal to or greater than the area of Inlet 47 (which is similar to inlet 43) of blower 48. Accordingly, blower 48 is not choked or hindered in performance in any way even though inlet 47 faces bottom panel 27. Similarly, a standoff distance of y is defined between top panel 28 and blower 44. Distance y defines an intake area that is roughly distance y multiplied by the circumference of inlet 43 of blower 44. This

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intake area preferably is substantially equal to or greater than the area of inlet 43 of blower 44 to avoid hindering the performance of blower 44.

In the preferred embodiment, case 20 is a 2U case and thus has an outer height dimension of 88.1mm or roughly 3.47" at maximum. Assuming that top panel 28 and bottom panel 27 are each 90 mil (i.e. .090") thick, the inner height of case 20 between top panel 28 and bottom panel 27 is 3.29". Typical 96mm blowers are 33mm (1.3") thick. Therefore, two such blowers stacked on one another as illustrated take up at least 2.6" in the height dimension. Therefore, dimensions x and y can each be equal to about .345", ((3.29-2.6)/2=.345). Applicant has found that x and y can be preferably in the range of .206"-.370" inches inclusive, and most preferably in the range of .250" to .345", inclusive. Of course it is preferable to reduce the height of case 20 slightly below the maximum 2U specification to allow for torsion, and other variations. Therefore, x and y may be equal to about .250". Of course, when one of x and y is larger, the other becomes smaller.

The blower arrangement of the preferred embodiment permits two standard 96mm blowers to be positioned in a 2U case while only presenting the footprint of one 96mm blower. In other words the back to back stacked arrangement of blowers 44 and 48 minimizes their affective footprint by overlapping the footprints of blowers 44 and 48. Also, bays 30 and 34 are designed to accept components such as two standard width half height removable hard drives or three standard low profile hard drives. Half height hard drives have a length of roughly 6", a width of roughly 4", and a height of about 1 5/8". Therefore, three such drives can be stacked one on another in bays 30 and 34 within the dimensions of a 2U case because there is no need to place fans in front panel 22.

As illustrated in Figs. 1 and 5, bay 32 can accept DAT (digital audio tape) drive 112 that typically is about 1 5/8" high and PC card chassis 114 that typically is about 1" high. Bays 30 and 34 can each contain two ruggedized removable half height hard drives. In particular hard drives 100

and 102 are disposed in bay 30 and hard drives 104 and 106 are disposed in bay 34. The depth of standard half height hard drives is accommodated by bays 30 and 34 as illustrated in Fig. 1. Bay 30 can also accommodate pilot lights or buttons 120 and low profile floppy drive 110. Further low profile CD ROM drive 116 can also be housed in bay 34. As illustrated in Fig. 1, this configuration leaves a void space in the zone between partition 40 and bay 32. Blowers 44 and 48 in the configuration described above fit into this void space while permitting adequate air flow around bays 30, 32, and 34. Also, because inlet 45 and 49 face upward and downward respectively, cables (such as ribbon cable 60) and other conductors can be directed around side portions of blowers 44 and 48 as illustrated in Fig. 1. Such cables can provide communications and power connections between the various components. Also, typical 96mm blowers deliver about 25 ft ^{3}/min of airflow. Accordingly, the preferred embodiment has 50 ft ^{3}/min of airflow therethrough. Should one of blowers 44 and 48 fail, the other blower can adequately cool the various components for limited duty. A standard techometer feedback can be used to detect failure of a blower and to enunciation of an alarm or the like.

Motherboard 36 includes plural memory module slots 50 (for supporting SDRAM memory modules, EDO memory modules, SIMMS memory modules, DIMMS memory modules, or the like), expansion card slots 52 (PCI, ISA, EISA, AGP, or the like), processor 54 and various other components and connectors in a known manner. The well known "ATX form factor" motherboard is roughly 12" x 13". Power supply 38 can be a standard 2U power supply. The dimensions of standard power supplies are about 4.5" X 8.25". Accordingly, power supply 38 and motherboard 36 can be placed next to one another as shown within the width dimension of case 20 which is made to fit in a standard 19" rack.

As illustrated in Figs. 1-3, partition 40 has bent portions formed on an upper edge thereof to define cable channels 41 extending through partition 40

to permit power cables, communication cables, and the like to pass through partition 40. For example, ribbon cable 60 from an IDE hard drive in bay 34 extends through either one of channels 41 to an IDE controller connector on motherboard 36. As illustrated in Fig. 4, each channel 41 is defined by bending a portion of the top edge of partition 40 at roughly a 90 degree angle. Of course, it may be necessary to form small cuts in partition 40 to define the width of channel 41. The width of channel 41 can be set to be slightly larger than the width of the largest ribbon cable to extend therethrough. It can be seen that the bent portion defines a smooth flat surface of channel 41 on which ribbon cable 60 can rest. Also, resilient member 62 (illustrated with a dotted line for clarity), such as a gasket or other seal, can be disposed on a surface of top panel 28 in opposition to the top edge of partition 40 to seal channel 41 around ribbon cable 60. Resilient member 62 can extend along the entire length of partition 40 or only in opposition to channels 41 or other portions of partition 40.

As illustrated in Fig. 2, top panel 28 includes wrap-around portions 29 that extend substantially orthogonally to main portions of top panel 28. Wrap-around portions 29 permit top panel 28 to be secured to side panels 24 by fasteners, such as screws 66, which extend through wrap-around portions 29 and side panels 24. This arrangement avoids screw heads on the main portion of top panel 28 to thereby reduce the clearance needed between top panel 28 and another unit disposed in a rack directly above top panel 28. Accordingly, case 20 can have a slightly larger inner height dimension or top panel 28 can be slightly thicker to increase the mechanical strength and rigidity of case 20. Further, wrap-around portions 29 extend into a void space defined by slide out mounting rails 70 which are attached to side panels 22. Accordingly, wrap-around portions 29 do not add to the effective width dimension of case 20 which must fit into a standard sized rack. Fig. 2 illustrates slide out rails 70 on case 20. It can be seen that any portion of the heads of screws 66 that extends beyond wrap-around portions 29 will extend

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into a void space defined by rails 70 between side panels 24 and sides of rack 72 (shown with a dotted line) in which case 20 is mounted.

Fig. 6 illustrates case 10 having modified partition 40 having offset portions 40a and 40b connected by connecting portion 40c. This arrangement allows different proportions of the zones for accommodating a mini ATX motherboard in a shallower case for example. Other elements for the case of Fig. 6 are similar to that of Fig. 1 and are unillustrated or labeled with like reference numerals.

The invention can have any components in any configuration. For example, various power supplies, drives, motherboards switches and memory devices can be used. The invention can be used in any size computer. The case can be rack mounted or free standing.

While the foregoing description includes many details and specificities, it is to be understood that these have been included for purposes of explanation only, and are not to be interpreted as limitations of the present invention. Many modifications to the embodiments described above can be made without departing from the spirit and scope of the invention, as is intended to be encompassed by the following claims and their legal equivalents.